SCIENCE

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CHEMISTRY OF PENICILLIN

By the Committee on Medical Research, O.S.R.D., Washington, and the Medical Research Council, London

THIS brief summary of results obtained by British and American chemists, issued under the joint auspices of the Committee on Medical Research (O.S.R.D., Washington) and the Medical Research Council (London), is a preliminary notice of the principal findings secured up to the end of 1944 in a collaborative effort of a large number of investigators, unnamed at present. It implies some corrections of published data; authors of early publications are among those who have cleared up these points. For the sake of clearness, the account is not given in chronological order of development. The primary object of this communication is to disclose significant facts which have been confirmed by unequivocal synthesis and to record a few essential points which are still matter for conjecture. Full details will be published at a later stage, together with an account of experiments not referred to in this report.

Several antibiotics of the penicillin class are known and all have the empirical formula $C_9H_{11}O_4SN_2 \cdot R$. In F-penicillin (known in Britain as penicillin-I), R is Δ^2-pentenyl, $-CH_2 \cdot CH{=}CH \cdot CH_2 \cdot CH_3$; in dihydro-F-penicillin, R is *n*-amyl; in G-penicillin (known in Britain as penicillin-II), R is benzyl; in X-penicillin (also known as penicillin-III), R is *p*-hydroxybenzyl; in K-penicillin (a recent addition to the series), R is *n*-heptyl. The best elementary analyses are of pure crystalline sodium salts. Determinations of the molecular weights of the sodium salt and of the methyl ester of G-penicillin indicate that the empirical formulae truly represent the molecular weights.

The penicillins are strong monobasic acids of pK about 2.8; electrometric titration does not disclose the presence of a basic group. Slow titration with perchloric acid in acetic acid solution indicates such a group, but the penicillin is biologically inactivated by this treatment; rapid titration gives a negative result.

The ultraviolet and infrared absorptions, crystal

structure (by x-ray methods, including full electron distribution of the rubidium salt of G-penicillin) and polarimetric and polarographic behavior of the penicillins and their derivatives have been studied.

Sodium G-penicillin contains one hydrogen atom replaceable by deuterium on equilibration with heavy water.

On treatment with hot dilute mineral acids the penicillins afford one molecule of carbon dioxide, an amino acid termed penicillamine and other products. Penicillamine, obtainable by several other degradation processes, has been identified by analytic and synthetic methods as *d*-β,β-dimethylcysteine. Penicillamine with the same steric configuration is derived from F- and G-penicillins; it belongs to the *d*- or "unnatural" series of α-amino acids.

Synthetic penicillamine has been resolved, and numerous derivatives of the optically active enantiomorphs and the racemic form have been prepared. These include penicillamine disulfide (tetramethylcystine) and penicillaminic acid (dimethylcysteic acid) as well as a long series of thiazolidines and S- and N-substituted derivatives.

After removal of penicillamine from the acid hydrolysates of F-penicillin, careful treatment allowed of the isolation of an aldehyde, $C_8H_{13}O_2N$, in the form of its 2,4-dinitrophenylhydrazone and its condensation product with dimedone. Similarly, dihydro-F-penicillin gave rise to derivatives of an aldehyde, $C_8H_{15}O_2N$. G-penicillin afforded phenaceturic acid, phenylacetamide and an aldehyde, $C_{10}H_{11}O_2N$. Phenylacetic acid had previously been recognized as a hydrolytic product of G-penicillin.

These penilloaldehydes have been identified by analysis and synthesis as follows: F-penilloaldehyde, Δ^2-hexenoylaminoacetaldehyde; dihydro-F-penilloaldehyde, *n*-hexoylaminoacetaldehyde; G-penilloaldehyde, phenylacetylaminoacetaldehyde.

It was inherently probable that the carbon dioxide liberated when penicillin is hydrolyzed in hot acid solution was derived from an unstable carboxyl group and, taking into consideration the nature of penicillamine and the penilloaldehydes, a probable precursor was penilloaldehyde-carboxylic acid,

$$R \cdot CO \cdot NH \cdot CH(CO_2H) \cdot CHO$$

now termed a *penaldic acid.* This was conclusively demonstrated to be correct.

G-penicillin and benzylamine afford a crystalline compound, $C_{30}H_{36}O_4N_4S \cdot H_2O$, which has the composition of a hydrated addition compound of one molecule of G-penicillin and two molecules of benzylamine and is the mono-benzylamine salt of the mono-benzylamide of a dicarboxylic acid. Degradation of this substance by means of mercuric chloride afforded penicillamine and G-penaldic acid benzylamide which was catalytically reduced to hexahydrophenylacetylserine hexahydrobenzylamide,

$$C_6H_{11} \cdot CH_2 \cdot CO \cdot NH \cdot CH(CH_2OH) \cdot CO \cdot NH \cdot C_7H_{13},$$

identified with a synthetic specimen.

The penicillins are readily inactivated by methanol and the products are methyl esters. Methanol-inactivated G-penicillin was degraded to methyl G-penaldate,

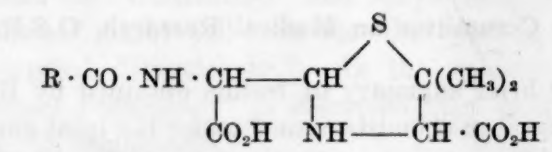
$$C_6H_5 \cdot CH_2 \cdot CO \cdot NH \cdot CH(CO_2CH_3) \cdot CHO$$

the constitution of which was proved by its catalytic reduction to N-hexahydrophenylacetylalanine. The latter was identical with a specimen prepared by similar reduction of phenylacetylalanine. F- and G-penicillins are converted by the action of diazomethane into mono-methyl esters and these are degraded by mercuric chloride in aqueous solution with formation of the methyl ester of penicillamine.

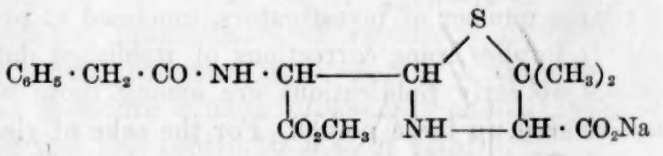
These observations serve to show (1) that the acidic group in penicillin is identical with the carboxyl group in penicillamine, (2) that by the addition of the elements of water to penicillin a second carboxyl is produced, (3) that it is this new carboxyl which breaks down to carbon dioxide by the action of hot dilute mineral acids.

The dicarboxylic acid obtained by hydrolysis of penicillin at the site of the potential carboxyl is termed *penicilloic acid.* This acid is produced in the form of salts by treatment of penicillin with alkalies and is presumably the product of the action of the enzyme penicillinase on penicillin.

Derivatives of penicilloic acid have been synthesized and the outcome of much work that can not here be described in detail is that penicilloic acids are undoubtedly thiazolidines of the formula:



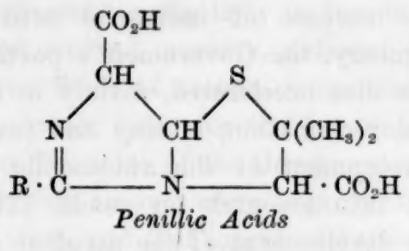
where R is one of the groups already particularized. Thus, "methanol inactivated" sodium G-penicillin is one of the stereoisomeric forms of the structure:



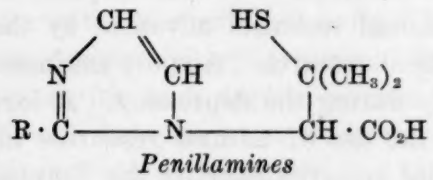
When any of the penicillins is held in dilute mineral acid solution at about 30° a change occurs which may be followed polarimetrically. Crystalline isomerides of the penicillins, termed *penillic acids,* may then be readily isolated. These substances are shown by electrometric titrations to be dibasic acids containing a basic group; thiol groups are absent.

Treatment of the penillic acids with cold aqueous mercuric chloride involves loss of a molecule of car-

bon dioxide and formation of substances termed *penillamines*. These compounds are mono-basic, monoacidic and contain a thiol group. Analysis and synthesis have shown that the annexed expressions represent the respective structures:

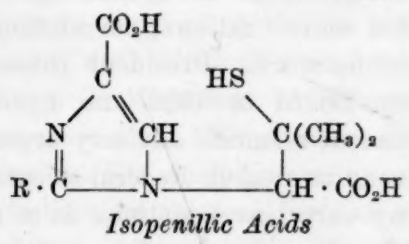


Penillic Acids



Penillamines

Hydrolysis of the penillic acids by hot dilute acids affords penicillamine, the penilloaldehydes and carbon dioxide but the penillamines are resistant to hydrolysis. F- and G-penillic acids are convertible by baryta into the isomeric isopenillic acids.

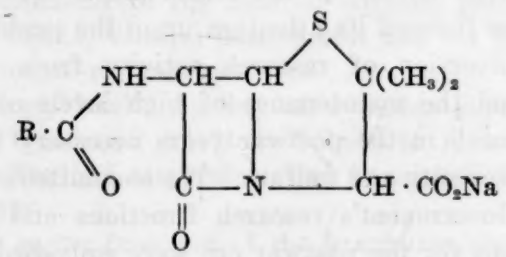


Isopenillic Acids

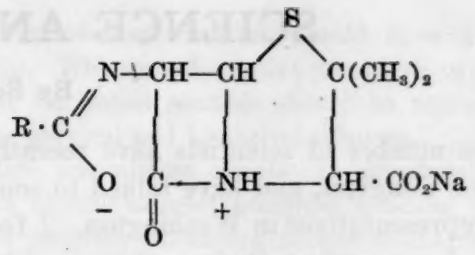
Methyl G-penicillin is changed by mercuric chloride in neutral media into the isomeric methyl G-penicillenate which, on hydrolysis by means of aqueous sodium hydroxide, affords the sodium salt of 4-hydroxymethylene-2-benzyloxazolone. The addition of the elements of thiocyanic acid to methyl penicillin and the transformations of the primary product have been investigated in detail with important results.

Finally, the action of Raney nickel catalyst on sodium G-penicillin in aqueous solution affords desthio-G-penicillin, $C_{16}H_{20}O_4N_2$, together with phenylacetyl-*l*-alanyl-*d*-valine, $C_{16}H_{22}O_4N_2$.

Naturally the workers in this field have formed views as to the full constitution of the penicillins. At present it can be stated that the formulae which are now receiving the most active attention contain respectively a β-lactam structure (I) and an incipient azlactone grouping (II):



I



II

The following groups have participated in the joint program for the chemical study of penicillin:

In Britain:

*Boots Pure Drug Company, Ltd.
*British Drug Houses, Ltd.
Cambridge University, Department of Chemistry
Cambridge University, Department of Colloid Science
*Glaxo Laboratories, Ltd.
Imperial Chemical Industries, Ltd. (Alkali Division)
Imperial Chemical Pharmaceuticals, Ltd.
Imperial College of Science, London, Department of Organic Chemistry
The London Hospital Medical Unit
Manchester University, Department of Chemistry
*May and Baker, Ltd.
National Institute for Medical Research, Hampstead, London
Oxford University, Department of Crystallography
Oxford University, Dyson Perrins Laboratory
Oxford University, Sir William Dunn School of Pathology
Oxford University, Department of Physical Chemistry
*Wellcome Foundation, Ltd.

* Members of the Therapeutic Research Corporation of Great Britain, Ltd.

In the United States:

Abbott Laboratories
U. S. Department of Agriculture, Northern Regional Research Laboratory
Cornell University Medical College, Department of Biochemistry and Russell Sage Institute
Cutter Laboratories
Federal Security Agency, Food and Drug Administration
Harvard University, Department of Chemistry
Heyden Chemical Corporation
University of Illinois, Department of Chemistry
Eli Lilly and Company
Merck & Co., Inc.
University of Michigan, Department of Chemistry
University of Michigan, Department of Physics
National Bureau of Standards
Naval Medical Research Institute
Parke, Davis and Company
Chas. Pfizer & Co., Inc.
The Rockefeller Institute for Medical Research
Shell Development Company
Squibb Institute for Medical Research
The Upjohn Company
Winthrop Chemical Company, Inc.

SCIENCE AND THE GOVERNMENT[1]

By Senator H. M. KILGORE

A LARGE number of scientists have recently visited the halls of Congress, and have talked to some of the people's representatives in Washington. I feel, therefore, that I am perhaps only making a return visit when I appear before you this evening. I think it has been a good thing, and a healthy thing, for the scientists and the politicians to get to know each other better. The urgency of the times has forced us together, and I hope that the acquaintance will develop into a lasting and fruitful relationship.

There may be some scientists here this evening who want to know why the Government is concerned with affairs of science. I want to quote you a sentence from the writings of George Washington, who died in 1799. Washington believed, and said, that the "arts and sciences are essential to the prosperity of the state and to the ornament and happiness of human life."

The Founding Fathers believed that the Government should sponsor scientific research, and they incorporated into the Constitution a clause to the effect that the Congress should provide for the common defense and promote the general welfare. It is under the general-welfare clause that most of our peacetime research has been inaugurated. Expeditions and surveys have been sent out to explore and examine the national domain, and this examination has continued in greater detail as the various sciences developed.

Military necessity early called for Federal support of research. The first Federal research agency was for military ordnance and was established during the War of 1812. Three war-time research agencies were created during the Civil War, six during World War I and 12 during World War II.

Between wars there has been a consistent growth of Government research agencies for the general welfare. The first Federal grant in support of peacetime research as such was made in 1836, when steamboats were constantly blowing up and causing one disaster after another. In an attempt to remedy this situation, the Government made a grant of $10,000 to the Franklin Institute to find out the reasons and try to remedy them for the safety of steamship passengers.

The Department of Agriculture, an agency of research for farmers, was established in 1862. The Weather Bureau was established in 1890, the National Bureau of Standards in 1901, and I could name many other scientific agencies which have helped do the things which common citizens and taxpayers could not carry out alone.

With the increase of industrial activity in the twentieth century, the Government's participation in research was also accelerated, mainly in agriculture, conservation, reclamation, mining and forestry. Industrial development of the automobile forced the Government into research on roads. The nation's stake in the development of the airplane led to government-financed technical advances by the agencies of aeronautical research. Airport engineering developed largely during the depression. A logical development in the use of natural resources in a region is the applied research done by the Tennessee Valley Authority.

As science grew in importance, its recognition in the structure of the Government at a high level has been urged repeatedly. The National Academy of Sciences in 1884 recommended a Department of Science. The Congress, in 1903 and again in 1908, recommended a more "rational correlation" of Government scientific work. President Roosevelt's Science Advisory Board in 1933 and again in 1935 urged a permanent scientific advisory organization.

My own strong interest in Federal scientific activity dates from my early investigations as a member of the Senate War Investigating Committee headed by Senator—now President—Truman. Our studies in 1941 and 1942 of the mobilization of our resources showed weaknesses in the use of scientific data. In the synthetic rubber program, for example, a number of false starts were made because of the lack of adequate data in the hands of responsible government agencies.

In the fall of 1942 I introduced a science mobilization bill, and the Senate created within the Military Affairs Committee a special subcommittee of which I have had the privilege of serving as chairman, to study the scientific and technological problems of the war effort. Many of the objectives of better organization and enlargement of wartime research which have been set forth by the committee have been achieved, under the War Powers Act, by administrative action.

When the defeat of the Axis was imminent, the committee focused its attention upon the problems of the reconversion of research activity from war to peace, and the maintenance of high levels of scientific research in the postwar years necessary for our national security and welfare. The committee's studies of the Government's research functions and recommendations for the postwar era were embodied in the

[1] An address given before the Science Society of Washington, Washington, D. C., the Technical Reserve of the Naval Ordnance Laboratory and the Section on Social and Economic Sciences of the American Association for the Advancement of Science, at Washington, D. C., December 5, 1945.

committee reports of January and July of this year. Our major conclusion, which closely paralleled that of Dr. Vannevar Bush's committee studying the problem for the Executive Branch of the Government, was that the Federal Government should greatly increase support of science, particularly in the basic sciences, in health and medical research, national defense and other research fields of recognized public interest.

Both the studies made for the Legislative and for the Executive Branches of the Government found that science is playing an ever more important part in the life of the nation, and that increased funds are needed to finance the nation's scientific activity. It appeared that for non-commercial-type research, whether for basic science or for such applied science as medical research, the sources upon which we have relied in the past, notably private philanthropy, can not meet the need in the future. It was accordingly recommended that public funds be used to create a widespread wealth of skills, ideas and facilities as an investment in national prosperity and peace.

During October, our subcommittee held public hearings on bills embodying the recommendations for increased peacetime support of science and providing for the creation of a Federal scientific foundation. Senator Warren G. Magnuson of Washington and I jointly heard more than 100 witnesses from all sections of American life, including many eminent specialists who testified on the need for such a foundation and the problems involved in its creation. With a single exception, these witnesses, representatives of industry, agriculture, labor, veterans groups, governmental agencies and scientific and educational groups and institutions, urged the creation of a Federal scientific foundation.

During the past two weeks I have been analyzing the testimony. The hearings have provided a public record on the basis of which recommendations can be made to Congress, and on which Congress can act with every assurance that it is meeting a vital national need in an effective manner. Let me give you a short summary of the testimony urging Congress to create a Federal science foundation to finance increased scientific activity:

(1) The witnesses believed that support of science was an essential of any national defense program.

(2) They believed that such support would make manifold contributions to the national welfare, particularly in public health, cultural development and the technical development of regional resources.

(3) A considerable number of witnesses pointed out that the foundation would contribute to international understanding and cooperation, and would help to avert another war.

(4) As to the functions of the foundation, those who spoke of it at all were unanimous in their agreement that basic or fundamental research should have government sponsorship. Widespread support was given to the proposition that the social sciences should be represented, as well as the physical and biological sciences.

(5) There was almost unanimous agreement that the foundation should support scientific training through a federal-aid program of undergraduate scholarships, postgraduate and postdoctoral fellowships.

(6) A great many witnesses urged that the foundation should maintain an up-to-date roster of scientific personnel.

(7) All witnesses agreed that the freedom of the individual working scientist must be maintained. Some were afraid of "political control" of science, but were reassured by other witnesses who pointed to the freedom of scientists working in Government departments and agencies.

(8) A majority of witnesses agreed that the foundation should coordinate research financed by the Government. The best way to do this, they agreed, was through voluntary joint planning and full exchange of information.

(9) And, finally, it was generally agreed that the foundation should promote the widest possible dissemination and utilization of scientific discoveries and techniques.

These are the things that you and your colleagues told me and the other Senators in Washington recently. I am not a scientist and I will not pretend that my approach to this problem is identical with yours. Yet it is my firm belief that the needs of the American scientists and of the American people, part of whom I have the honor to represent in Congress, are identical. I have become convinced, and I think many of my colleagues are convinced, that the free and unrestricted development of basic scientific research is such an important part of our potential national resources that we can not afford to neglect it. I feel that in order to discharge my responsibility to my constituents and to the people of America I am obliged to do whatever I can to encourage the growth of basic scientific research.

Now what does this mean? Will it be adequate merely to increase the funds available for scientific research? I think not.

There are, of course, many ways in which federal funds could be used to support American science. During the last five years I have given this matter much thought. I have considered many alternatives, and in each case I have abandoned them in favor of a National Science Foundation.

For instance, we could simply appropriate funds to each of the 48 states and tell them that they are to be used to support science. In effect, this would necessitate the establishment of 48 state science foundations.

Or we could make appropriations direct to each of the colleges and universities of the country in proportion to their enrolments. Then, instead of 48

local science foundations, we would have hundreds. I doubt, and believe you doubt, that such schemes would result in equally effective programs of research in national defense, health and medicine, and other fields of national interest.

Or again, we could make appropriations for non-profit institutions which would, in effect, include private research foundations such as the Rockefeller, Sage or Carnegie foundations. Although I have the greatest respect for the purposes and practices of those and similar great organizations, I can not bring myself to believe that the American people would want, or Congress would defend, this manner of expending government funds.

Finally, we could appropriate federal funds directly to the National Academy of Sciences or its operating organization, the National Research Council. I assure you that this possibility has received serious consideration. The reason for not following this procedure is that, although these agencies were established by an Act of Congress and by Executive Order, they are not true Government agencies but have a quasi-public status. I shall discuss this point later.

An entirely new Government agency is needed. It is needed not only to provide the necessary federal support for science, not only to assure that the funds are spent on programs related to national welfare, but because science itself has now become such an integral part of government. I believe that you scientists want and deserve more than a government dole for your research.

I do not feel that the Government should tell you what to do or that the proposed Federal agency should exercise scientific judgment and attempt to make decisions which can only be made by the individual investigators. No, I am not proposing that you pay for these funds by giving up that freedom without which true scientific research would soon cease to exist. I think I can best explain what I mean by reference to the urgent scientific problem of the day—atomic energy. This problem is not only a major *scientific* problem but also the most important *political* issue of the day. You know better than I what this problem has meant to the scientists who have worked on the atomic bomb. These men received tremendous financial support from the Government. They did their job and they did it well, but it was a one-way affair. They were hired by the Government to do the job, but were given no opportunity to have a voice in what would be done with the new knowledge that they produced and applied. And now these men—and I applaud them for it—are making every effort to find some means of making their voices heard.

Science has reached such a stage of development that we must expect huge and far-reaching developments to come out of our laboratories. If we accentuate this process by increasing the financial support given to scientific research, the scientists will be continually faced with a similar situation. What is the solution? I propose that the Government not only give the scientists more money and better laboratories; I propose, too, that the Government make a place for the scientists in its very structure so that, as scientific knowledge advances, we shall also provide for a voice for the scientists. I think scientists deserve it, and the country needs it.

The need for bringing more scientific men into the Government is a critical part of the problem of the proposed Science Foundation. The foundation simply can not be administered by laymen. Its entire operation requires the scientific insight and knowledge which only the trained scientists can contribute.

Now it has been argued that we can not solve this problem by bringing scientists into the Government to operate this agency. It has been suggested by some that, instead, we shall have to depend on the part-time assistance of a scientific board who will hire administrators to run the foundation for them. I think, however, that the Government needs more than the part-time services of scientists. I think that we need some of you in Washington all the time, and one of your jobs should be to run the Science Foundation.

I know that this is something of a new departure for scientists. I know that it is a great deal to ask of a man who has spent a lifetime building up a career which is in many ways far removed from matters of public administration. Yet, without the full-time services of men who understand the scientific laboratory from the inside, any scientific foundation is doomed to failure. This issue can not be avoided. Many scientists have said at our recent hearings that the proposed Science Foundation must be under the control of scientists. With this, I heartily agree.

Science must have, and must have *now*, a full-fledged Government agency run by scientists. I think that this is necessary because, without it, the Government scientific activities can not be properly guided.

I will not discuss further the major areas of agreement revealed in the testimony. This evening I shall take the opportunity to discuss with you those aspects of the proposed foundation in regard to which there is a lack of general agreement or in regard to which misunderstanding exists. These include:

(1) The best form of organization for the proposed foundation—and here the principal discussion concerns the top management.

(2) The best way to assure in the legislation creating the foundation the full publication and free dedication to the public of the results of federally financed research.

(3) The best way to deal with the human—the social and economic problems which scientists can help solve.

Before final congressional action can be taken to create the needed foundation, agreement must be reached on these features. I believe that the extensive public record provides an adequate background for intelligent legislative action on these moot points. Before discussing them in detail, let me say a word about the manner, and the degree of precision, of the results which must be obtained.

Legislators—like scientists—must seek not only yes and no answers, but must also make determinations within practicable limits. In the various scientific disciplines, methods have been arrived at for achieving the necessary degrees of precision. Similarly, in Congress, we have an elaborate process for achieving results with the degree of precision appropriate to legislative action.

A bill introduced by a member of Congress is seldom voted on in its initial form. First through public hearings, then through deliberations of the committee and of the chamber as a whole, it is shaped toward its final workable form. Even after its enactment, its practicable application is reviewed annually when appropriations are made. Further, Congress can—and often does—modify the original enabling legislation by subsequent amendments based on the year to year experience of the agency. It is in the light of this process that we must seek to create for the new foundation an initial organizational structure so designed that it will have the greatest possibility of successfully accomplishing its purpose.

If we agree, then, that a National Science Foundation is needed and that the financial support of this foundation must come from federal funds, let us turn to a consideration of the problem of how the foundation should be administered in order that its functions may best be realized. Before attacking this problem directly, permit me to digress into a brief discussion of just what a Government agency is, noting where it differs from a private corporation whether of the industrial or institutional variety.

In order to appreciate the unique characteristics of a Government agency, let me ask each of you to imagine yourself for a moment a member of the Congress of the United States. As the elected representative of a segment of our people, I am sure you would feel, as I do, a heightened sense of responsibility to see that all agencies of the Government are operated not only in an efficient manner but in the best interests of the nation as a whole. From such a vantage point I am sure you would realize how very vigilantly we, as the members of Congress, seek to protect the rights of all the people in the enactment of any legislation involving the appropriation of taxpayers' money. Thus, in establishing a Federal agency to which we commit ourselves to make annual appropriations, one of the thoughts uppermost in our minds is that the agency be a true servant of all the people; and that, even under the most unfortunate selection of administrative personnel, we must protect the public from the possibility that the agency may become the instrument of special-interest groups, which, as you may know, are rather plentiful in our democracy. It is for this that the *sine-qua-non* of any Government agency is that its powers be vested in full-time Government employees whose principal responsibility is their public function, and who have severed all previous connections with private financial interests. From the Government standpoint it is unthinkable that the powers of the proposed National Science Foundation be vested in a board of non-compensated persons, whose principal responsibilities would lie in some other direction, as some scientists have so urgently and so honestly recommended. This is not to say that we, the trustees of the taxpayers' money and interests, impugn the integrity of those scientists who might be appointed to such a board. It is to say that we feel under the highest obligation to assure the people of the United States that under no conditions, at any future time, could the foundation conceivably be regarded as the agency of any special group.

Many scientists testified in the hearings and many have written to me personally that they are convinced of the superiority of the board form of organization. I respect the sincerity of their testimony in this matter and believe I understand why their analysis of the situation leads them to prefer this form of organization. Most scientists have spent their lives in universities and have worked with or under research foundations administered by a board of trustees or directors. In most instances, these groups of men are appointed or elected to serve as trustees of certain funds which private philanthropy has bequeathed. As trustees of these funds, it is their duty to assure that the funds are spent for the purpose or purposes specified in the bequest. In order to utilize the funds, the board of trustees establishes an operating agency, *i.e.*, a university or foundation, and then selects and hires an administrative officer who in turn selects and hires the technical operating staff. But note that it is this highly trained operating staff which carries out the actual work of the organization. The board of trustees simply meets from time to time, reviews policy, and in approving budgets gives its approval or disapproval to the programs proposed by the operating staff of the organization.

A foundation under a single administrator will have a board of trustees, and the board of trustees appro-

priate for all Government agencies is the Congress of the United States. Congress can not delegate its constitutional responsibilities or turn them over to any subsidiary board of trustees, no matter how distinguished its members may be.

Let me again emphasize that the success of any operating organization, whether a private industry, a university or a government agency, depends primarily on the quality of the technical personnel which makes up its operating staff. It is not the Board of directors or the trustees which do the scientific work of a university or a foundation; the same holds for the proposed National Science Foundation. The foundation will succeed only if, after its establishment, we are able to staff it with the very ablest scientists in the United States.

It will be the business of the foundation to administer a large segment of federally sponsored research. Just as the business of the Federal Trade Commission is carried on by full-time Government employees with the training and experience in economics and financial transactions, the National Science Foundation must be administered by a staff composed of first-class scientists devoted to the public service. And unless there are enough able scientists in this country who recognize the importance of this job of administering scientific activities, and unless such men are willing to accept full-time jobs on the staff of the National Science Foundation, it can not succeed in carrying out the functions which our recent hearings show to be so greatly needed. Now that science has come of age, there must be those among you who are willing to forego the role of the working scientist to accept the challenge of a new career in the administration of scientific research. I do not know how large a staff it will have to be. In the bill S.1297, we have specified only a full-time administrator, a deputy administrator and a director for each of the separate divisions. Obviously these men will need many assistants in all fields of science. I do know that we can not expect the business of the foundation to be properly conducted by part-time employees who come to Washington a few days every month and then go back to their regular jobs. The activities of the proposed foundation will be so manifold and so important that they must be administered ably, continually and efficiently if the foundation is to succeed. I say to you frankly, if I were not convinced that there are those among you who are willing to accept the challenge of these tasks, I would not support the legislation to establish a Science Foundation.

If we agree that the National Science Foundation must be a Government agency, rather than a quasi-public foundation receiving Government appropriations, and if we agree that the powers of such an agency must be vested in full-time Government employees with no responsibilities other than to science and the nation, we must still face the problem of the best form of top administration. This problem is not unique to the proposed National Science Foundation; it is a problem which concerns us every time a new agency is established. Many experiments in administration have been tried in an effort to find the best answer to this difficult problem.

There are two general solutions to the problem of top administration. Both are known to be workable solutions, yet both have very real advantages and disadvantages. The first solution is that of having the President appoint, with the advice and the consent of the Senate, a single administrator in whom all powers of the agency are vested. This administrator in turn selects and hires other Government employees as his divisional chiefs. These in turn select and hire subordinates, and thus there is created an operating organization with a direct line of responsibility centering in the single administrator. This form of organization works. It is used in all governmental departments and in certain of the bureaus of these departments. It has also been successful in many agencies of the executive branch of the Government.

The advantages of the single administrator form of organization are clear-cut. All responsibility for the success of the agency is immediately identifiable. If the work of the agency is successful, the administrator gets the credit. If the work of the agency is unsatisfactory, the administrator gets the blame, and if the work is too unsatisfactory we get a new administrator! Every one working in the agency knows the lines of responsibility under which he works. This in general has been found to make for more efficient administration.

The disadvantages of the single administrator form of administration are simply stated. It involves placing tremendous responsibilities in the hands of one man. If he is a good man, that is, if he selects able administrative assistants and accepts their counsel in arriving at decisions, he will run a good agency. On the other hand, if the wrong man is selected and he fails to build up an efficient operating organization, and furthermore if he refuses to seek and accept advice as to the manner in which the agency should be administered, he will fail as the responsible individual. Fortunately, because he is immediately identifiable, he can be removed by the President and a new administrator appointed.

The alternative general solution which has been found successful in the administration of Government agencies is the board or commission form of organization. In this case the President, with the advice and consent of the Senate, appoints several full-time

Government employees to constitute the top administrative organization. In some cases, members of the commission elect their own chairman, and in some cases the President designates the chairman. In general the board or commission form of administration has been found to be successful when it has judicial functions, such as passing on rate questions, determining rights as between individuals or corporations. All the members of these commissions or boards are full-time Government employees.

The advantage of the board or commission form of administration is that it permits combining the wisdom of several at the top level of administration. In establishing the size and characteristics of commissions, the President and Congress attempt to include representatives of all interested groups in the hope that the special biases or predilections of the individuals will be cancelled out in the deliberations of the board, thus resulting in decisions more nearly reflecting policies in line with national welfare.

The disadvantages of the board form of administration can also be simply stated. It is a somewhat more unwieldy form of administration, and it is more difficult to identify the responsibility for satisfactory or unsatisfactory policies, decisions and programs. In case the program of the agency becomes too unsatisfactory it is necessary to replace at least a majority of the board before achieving the needed correction. As you can see, this requires considerably more time, and I may say replacement is less likely to happen than in the case of a single administrator.

I assure you that many of us have given a great deal of thought as to which general form of administration will be most satisfactory for the proposed National Science Foundation. As I see it, there are three general alternatives:

A. A single administrator, appointed by the President, with the advice and consent of the Senate, in whom will be vested sole authority for operating the foundation.

B. A board of three to nine full-time members, appointed by the President, with the advice and consent of the Senate; at the time of appointment one of the members of the board shall be designated by the President to serve as chairman.

C. A single administrator appointed by the President with the advice and consent of the Senate and a top advisory board of five to fifteen representative members, appointed by the President, to serve in a part-time capacity while continuing their regular professional work with universities, industries or other organizations.

These three general alternatives seem to be the only feasible forms of top administration for the proposed foundation. I honestly believe that, with the selection of the proper persons, any one of the three forms of administration would work and work effectively in the best interests of both science and the nation. I would be willing to join my colleagues in recommending that the bill about to be reported out provide for any one of these three alternatives. In the light of our general discussion of the problems of administering Government agencies, however, I wish to explain why I personally believe Alternative C represents the best possible set-up for the proposed foundation.

I prefer a single administrator, not only because it promises to make the administration of the foundation more efficient, but primarily so that all of us—the President, Congress, scientists and the public—will know at all times exactly who is responsible for the program of the foundation. Because of the manifold facets of science, I can not conceive a board of even nine men adequately representing all its interests equally and fairly. A single administrator, because he would operate under the spotlight of both public and scientific scrutiny, would not dare to omit an essential type of scientific endeavor from the program of the foundation.

On the other hand, I do not feel that this administrator should be asked to carry on the work of the foundation without the advisory service of the country's ablest scientists. Although I feel that any competent administrator would seek and utilize the advice of such an advisory board, even though he were not legally required to do so, I believe the law should include this feature and be so written that this advisory board could never become a mere perfunctory body. It is for this reason that we propose to require at least monthly meetings and to give the advisory board the privilege of direct access to the President and Congress. Under this organization, an administrator would not necessarily have to act in accordance with the advice of his advisory board, but, if he failed to do so, he would be obligated to defend to the public any alternative actions. It seems to me that we can depend upon such continuous public surveillance of the activities of the foundation to assure a minimum of unwise administrative action.

I believe that an advisory board, on which it is quite appropriate for citizens to serve on a part-time basis, would enable the foundation to secure the part-time assistance of any of the country's most able working scientists. To my mind the foundation would be more vigorous and would keep more closely in touch with the important problems of all fields of science if this advisory board were composed of men regularly engaged in administering or doing scientific work in the country's academic and industrial laboratories. It is for this same reason that we have recommended part-time advisory committees for each of the divisions. Even though we are able to hire the most able scientists as Government employees to staff the operating organization, they will require the continual stimula-

tion of outside working scientists if they are to continue to serve as effective members of the organization.

The composition of the top advisory board, it seems to me, might reflect the interests of the country as a whole. Of course, this means that scientists should be included on the top board but, at the same time, it means that industry, agriculture and labor might also be represented. They are the consumers of the fruits of scientific research. By contrast, at the divisional level, I would conceive the advisory committee to be made up almost exclusively of scientists. It is at the divisional levels that the truly scientific decisions of the foundation will be made. Not only must the Government employees who staff these divisions be competent scientists in their own right—they must have the advice of leading scientists both in and out of the Government laboratories in the planning and administration of the divisional programs.

In brief, I prefer alternative C because I believe it will result in the best administered foundation and provide the best opportunity for scientists to assist in the operation of the foundation both as Government officials and as advisers. And if we provide for limited single terms of office for advisory committee members, the foundation will retain a vitality which can not be achieved under any other form of administration.

As I have said, the other alternative forms of organization will probably work; and, if in the judgment of those who support the foundation, one of them should be clearly preferred, I should not be adverse to incorporating it in the legislation.

I think that we can all agree that the single administrator without an advisory board (Alternative A) is a much less adequate proposal. On the other hand, if full-time board or commission has certain advantages but, frankly, I think they are outweighed by inherent disadvantages. In the first place, a full-time board would mean that several of the nation's outstanding scientists would have to give up their present positions to become board members. Furthermore, unless we give such board members unlimited terms of office, it means that scientists appointed to the board would have a difficult time in returning to non-governmental positions after a term of board service. Over a period of years these board members would, as a group, become so identified with the foundation that they would assume a defensive attitude toward its program. It seems to me far better that we provide the foundation with a proven, efficient operating type of organization, but protect it from becoming bureaucratic by providing for a truly functional advisory board which would continually aid, scrutinize and criticize the program of the foundation.

Now, a few words on the utilization of research findings. The pure scientist is interested only in the truth, and we are agreed that the foundation should support a very strong program of basic research. But we must not overlook the fact that the group support of science is based on the belief that all knowledge of nature will eventually result in making our existence safer and more satisfying. There may be a few scientists left who are content with the mere discovery of a new fact or law—but I think that most scientists realize that even the most abstract discovery may have a world-shattering impact on civilization and society.

In spite of the fact that applied science has contributed increasingly to the destructiveness of successive wars, I am sure that most scientists are honestly concerned that their work be used for the welfare of mankind—not for its destruction. The problem of assuring the widest and wisest utilization of the fruits of research is indeed a knotty one. Because it is enmeshed with almost every phase of our culture and economy, I shall not pretend to solve it here this evening. I do, however, wish to comment briefly on the so-called patent issue associated with this science legislation.

Let me make one point clear, because it seems to have been misunderstood by some. The proposed legislation is in no sense a patent reform. It is not patent legislation, and it in no way changes the overall picture with respect to privately developed or privately owned patents. This was stated clearly by Commissioner Ooms, of the Patent Office, in the course of the hearings on these bills.

My bill to establish the National Science Foundation includes a provision to standardize the handling of all patentable discoveries growing out of all federally financed research. It is no more than an attempt to give the Government a logical and business-like policy, which, at the moment, simply does not exist. Your fellow scientists working in governmental laboratories need such a uniform policy. It is not equitable that a scientist working in one bureau receive the commercial rights to inventions which he makes and an equally competent fellow scientist in a different bureau be compelled to dedicate his patents to the public. Yet that is the situation as it exists to-day.

Granted that a uniform policy is desirable, to be of most value to science and the nation it must also be equitable and based on sound business principles. After much consideration and discussion with representatives of all interested groups, I am convinced that this basic policy should be one of full publication and free dedication of all findings, including patents, which result from federally financed research.

This conclusion is based primarily on two general lines of reasoning:

(1) A fair proportion of scientific discoveries are not patentable. Therefore, why should a scientific worker be rewarded because he happens or chooses to work on projects which yield results that can be commercially exploited? Would there not be a danger that good men would be enticed to work in the applied, rather than the fundamental, fields of research? Is there not the further danger that the possibility of patentable results would tend to conflict with free intercourse among scientists and the full publication of research? In other words—is not the policy of free dedication the one which most nearly conforms to the ideals and practices of scientists themselves?

(2) What policy with respect to patents represents good practice for the Government? Industrial laboratories require that patents developed by employees be signed over to the industry. This, they argue, is only fair to the stockholders, whose money not only builds the laboratories but also pays the salaries of the employees. It would seem that the policy of public dedication is dictated by the Government's responsibilities to its stockholders—the taxpayers. To put the question another way. why should the taxpayer contribute to the cost of a development and then later be forced to pay for it again because of a royalty which the manufacturer pays to the holder of the patent? Or worst yet (and this is not unheard of), would it be fair to the taxpayer if a patent based on Government-sponsored research should become the exclusive property of a company which refused to use it because it would not be to its economic advantage? Or can we defend the exclusive patenting of an important medical discovery? So—we have proposed the basic policy of full publication and free dedication.

However, it has been necessary to provide for certain exceptions to this basic policy. Certain types of developmental work needed by the military services can best be carried on in industrial laboratories, which are better equipped for some special kinds of work than non-profit laboratories. Such industrial laboratories, because they contribute a plant, an experienced staff and "know-how" to the project, are deserving of at least a portion of the commercial patent rights resulting from the research. Assuming this to be the case, we have made provision for exceptions to the basic policy of public dedication by stipulating that in those instances where the head of a Government agency (including the foundation) finds that a research project can not be carried out properly except in a private industrial laboratory, he is empowered to include special clauses in the contract to provide for a fair disposition of any resulting patent rights. However, to keep this provision from being unwisely used, it has been provided that each agency be required to publish the details of all such contracts within thirty days after executing them. In this way, I believe that we can be sure that special clauses will be used only when they are really in the public interest.

I wish that there were time to speak of the many other aspects of our problem. But there is one point to which my thoughts keep returning: Science is today at a crucial turning point, and we must find the road which will lead to its continuing advancement. If we are to find this road, we can not define science too narrowly. There are some who sincerely believe that the proposed legislation should exclude research in the social and economic fields. I wonder if this can wisely be done.

If studies of public health are found to involve social factors, should the foundation be prohibited by statute or hampered by lack of duly constituted research personnel and facilities from pursuing investigations in this direction? I am sure you will answer this question as I have answered it—in the negative. If surveys of our resources reveal the need to examine economic problems that are intimately related to their development, is the foundation to stop short of its goal because Congress failed to make provisions for economic research?

Congress would not meet its responsibilities to the public if it excluded research in those fields which are most directly concerned with human welfare. There is, I may say, reason to believe that a majority of scientists feel this way, for one of the scientific organizations represented here to-night testified at the hearings that two thirds of those members of its governing body who responded to a questionnaire on this point favored inclusion of the social sciences in the foundation. Probably these activities should be set up in a separate division coordinate with the natural sciences; but they should be there carrying their fair share of the burden of research.

We stand at the threshold of a new era of achievement in scientific research. Almost every field of science has at hand the basis for rapid advance. Even some of the less spectacular by-products of scientific research can be the starting point of new experimental methods and even of whole new sciences. The production, in significant quantities, of new radioactive isotopes opens up a vast new field of research in biology, chemistry, medicine and industrial sciences. I have listened enough to your colleagues to realize that the production of a radioactive isotope of carbon can make possible experiments which will plunge deep into the innermost secrets of physiological processes and of the behavior of organic chemicals. Yet, as one of the witnesses at our hearings pointed out, the cost of such isotopes is so great that only Federal support

can supply the funds which will make such experiments possible. Here is a clear case where the very progress of science depends on the establishment of Federal support of basic research.

John Quincy Adams, in his first message to Congress in 1825, said: "In assuming her station among the civilized nations of the earth it would seem that our nation has contracted the engagement to contribute her share of mind, of labor and of expense to the improvement of those parts of knowledge which lie beyond the reach of individual acquisition." Now, as the boundaries of knowledge are being rapidly pressed back, it is our obligation to provide the means for solving those problems "which lie beyond the reach of individual acquisition." I do not mean that we must find a substitute for the labors of individual scientists, for this is the very essence of scientific research. Rather I believe that the Federal Government must provide whatever the individual scientist needs to make his efforts bear fruit.

I know there are some who say that science has now become such a terrible instrument of destruction that we must now call a halt to its advancement. No scientist can support such an idea, and history has shown that every such attempt to restrain human progress is doomed to failure.

Rather I think that we must face the issue squarely. If we have now learned how to harness the very forces of the sun, if we can now achieve such scientific miracles, then certainly it lies within our power to solve the economic and political problems which threaten to turn our knowledge into destructive channels. This is an obligation which all of us must meet. And you, as scientists, have begun to play an ever-more critical role in this great project. I think that you and, indeed, the people of our nation should be proud of all the men of science who have begun to find the means of explaining to the world that scientific progress and human progress can not follow separate paths.

It is my firm purpose to do what I can, within the Congress, to provide for all science and for all scientists the support which they need and deserve. The proposed Science Foundation can be a national investment that may yield undreamed-of returns in knowledge, in wealth and in human progress. But its immediate value may be dwarfed if it will also make science a more vital part of our nation's heritage—if it draws scientists ever deeper into the stream of democratic advance that has made our nation great.

OBITUARY

LEONARD SALOMON ORNSTEIN

PROFESSOR L. S. ORNSTEIN died at Utrecht, Holland, in May, 1941, after an illness of several months. In November, 1940, all Jewish teachers were dismissed by the Nazis, and he was forbidden to visit his laboratory. An earlier illness returned, and he passed away before the full pressure of Nazi persecution was exerted against the Jews. His wife and three children, aided by many of his associates and former students, were able to live "underground" and have survived the war.

A student of Lorentz, Leonard Salomon Ornstein obtained his degree at Leiden in 1908. For a few years he occupied a lectureship in mathematical physics at Groningen. In 1914 he was called to the University of Utrecht as a successor to Debye in the chair of theoretical physics. Ornstein's interest soon turned to the experimental side of physics, and after serving as acting director for several years, he was appointed in 1925 director of the physics laboratory at Utrecht, giving up the professorship of theoretical physics, and devoting all his time to the direction of the research activities at the institute for the rest of his life. In 1931–32 he was rector of the University of Utrecht.

Ornstein's work, the extent of which may be judged from well over 200 publications, lay chiefly in problems of kinetic theory and in measurements of light intensity. In the first field, he contributed to the theory of Brownian movement and to the properties of liquid crystals. In the second, he secured his greatest fame for his development of the methods of photographic photometry and for their application to the measurement of spectral intensities. Under his direction, the photographic plate became an instrument of precision. In his laboratory was developed the well-known Moll microphotometer. Standards of light were established accurately to further the photographic methods.

Ornstein and his students made use of the exact quantitative measurement of spectral intensities in a wide variety of problems. As examples may be mentioned isotope ratios, accommodation coefficients, excitation functions of spectral lines by electron impact and diffusion coefficients. One of the early applications led to the empirical development of the familiar sum rules of multiplet intensities. From measurements of the intensities of band spectra it was established that some arcs are regions of thermal equilibrium at very high temperatures. This led not only

to wide studies of gas discharges, but also to an extensive program of determination of transition probabilities of excited atoms. Often only relative probabilities could be found at first, but in a few cases absolute values were secured, and eventually it may be expected, through interlocking, all values may be put on an absolute basis.

It is hardly an exaggeration to say the whole work of Ornstein's laboratory involved in some way the measurement of light intensities or the use of a blackened photographic plate. From biology to engineering Ornstein's fertile mind found application and uses for the principles he had developed.

In a sense unknown in American universities Ornstein was "the Professor." Intimately acquainted with all that was going on in his institute, he was able to keep in touch with the work of every individual through the Dutch "coffee table" around which each day at 11 o'clock would gather "the Professor" and some 20 or 30 of the faculty, assistants and advanced graduate students. To this coffee table and to his institute, it was Professor Ornstein's pride and pleasure to welcome students who came from all over the world to learn at first hand the methods he had developed.

R. C. MASON

RECENT DEATHS

DR. CHARLES SANDERSON CATHCART, for thirty-seven years State chemist at the New Jersey Experiment Station at New Brunswick, N. J., died on December 9.

DR. THEODORE H. FRISON, since 1931 chief of the Illinois State Natural History Survey, died on December 9. He was fifty years old.

MYRON S. FALK, of Greenwich, Conn., a well-known civil engineer and author of standard text-books on the design of bridges, died on November 26. He was sixty-seven years old.

STANLEY H. ZIMMERMAN, fifty-five, plant manager of the Post Products Division of the General Foods Corporation, and since 1939 a member of the board of control of the Michigan College of Mining and Technology, died on November 27.

DR. ALAN ESTIS FLOWERS, who, for the last twenty years was head of the research and development department of the De Laval Separator Company, died on December 4. He was sixty-nine years old.

THE death at the age of seventy-seven years is announced of Dr. Vladimir Leontievich Komaroff, the botanist, formerly president of the Academy of Sciences of the U.S.S.R. A state funeral was ordered for him.

SCIENTIFIC EVENTS

SELECTIVE SERVICE

IT is reported in a United Press dispatch that the Selective Service recommended to local draft boards on November 29 that they defer registrants who are studying or teaching physical sciences or engineering as part of a plan to increase the country's scientific knowledge.

Acting on a request by John W. Snyder, reconversion director, Selective Service sent a memorandum to local boards to the effect that "the demands of long-range national interest require a resumption of advanced studies for men having high technical and scientific qualifications."

It recommended that the boards give "serious consideration" to the deferment of registrants who are doing the following things:

1. Taking advanced studies and working for a master's or doctor's degree in the physical sciences or engineering.
2. Teaching physical science or engineering in an accredited college or university.
3. Doing university research in the physical sciences or engineering.

The program is aimed at developing fully the technical skills which had been acquired and to provide adequate teaching facilities for returning veterans who desired to resume their studies in these fields.

A committee to carry out the program was formed by representatives from the Office of Scientific Research and Development, the War and Navy Departments, the Civilian Production Administration and other government agencies. Under the plan:

Registrants will be certified by the committee for deferment only if their work contributes "significantly" to the national interest, and if they can prove that research would be delayed by inability to carry on their work.

Registrants wishing to be certified must present a notarized statement of their intentions to the Office of War Mobilization and Reconversion in Washington.

They also must present a statement signed by a "responsible" college or university official certifying that the registrant has been accepted as a candidate for an advanced degree, as a teacher, or as a research worker in physical sciences.

Any registrant who has completed at least three years of work leading to a bachelor's degree in science may be certified if he has served not less than two years in a project directly connected with the war effort.

The physical sciences are defined as including mathematics, physics and chemistry, and the engineering courses as including civil, mechanical and electrical engineering.

LIFE INSURANCE MEDICAL RESEARCH FUND

ONE hundred and forty-six life insurance companies in the United States and Canada have cooperated to establish an organization known as the Life Insurance Medical Research Fund. It is the purpose of this fund to support fundamental research bearing on cardiovascular disease, including rheumatic fever, hypertension, arteriosclerosis and allied disorders.

To assist the board of directors of the fund in making grants an advisory council has been appointed with the following membership: Dr. Francis G. Blake, *chairman;* Dr. Ernest W. Goodpasture, Dr. A. Baird Hastings, Dr. Eugene M. Landis, Dr. Robert F. Loeb, Dr. C. N. H. Long, Dr. Seeley G. Mudd and Dr. Cecil J. Watson.

Funds will become available after January 1, 1946, and grants will be made for varying periods of time in accordance with the specific requirements of the research problems.

Applications for grants may now be made to the chairman of the advisory council and should be transmitted in duplicate through the administrative officer of the institution making application. Requests for grants should include a description of the proposed research, a budget, and the date when funds are desired. Applications received by February 1, 1946, will be given consideration at a meeting of the council to be held on or about March 1, 1946.

FRANCIS G. BLAKE, M.D., *Chairman,*
Advisory Council
YALE UNIVERSITY SCHOOL OF MEDICINE,
333 CEDAR STREET,
NEW HAVEN 11, CONNECTICUT

STAFF CHANGES OF THE U. S. GEOLOGICAL SURVEY

DIRECTOR W. E. WRATHER, of the United States Geological Survey, has announced recent organizational changes within the Geologic Branch of the Survey, which is headed by Chief Geologist W. H. Bradley.

The Geologic Branch has been subdivided into two divisions and a technical service and administrative group. Dr. H. M. Bannerman has been named chief of the Division of Economic Geology. During most of the war period he served as chief of the Section of Non-metallic Minerals.

Dr. H. S. Ladd has been designated chief of the Division of Areal Geology and Basic Sciences. He was formerly regional geologist, in charge of the Rolla, Missouri, office of the Survey. Dr. J. W. Peoples, assistant chief geologist, has been named head of the Technical and Administrative Group.

A Special Research Staff has been set up within the Geologic Branch, having advisory functions in connection with long-range research planning and Branch policies. This staff includes Drs. D. F. Hewett, G. F. Loughlin and W. W. Rubey. Other geologists are temporarily assigned to this staff as the planning needs dictate.

A new Section of Geologic Information and Reports has been established. Don L. Carroll, until recently foreign editor and staff geologist of the *Oil Weekly,* has been designated chief of the new section.

The following sections now comprise the Division of Economic Geology:

Geology of Fuels: H. D. Miser, chief
Geology of Metalliferous Deposits: Charles P. Park, Jr., chief
Geology of Non-Metalliferous Deposits: Josiah Bridge, acting chief
Foreign Geology: J. V. N. Dorr, 2d, acting chief

Within the Division of Areal Geology and Basic Sciences are included the following sections:

Areal Geology: J. T. Hack, acting chief
Engineering Geology: E. C. Eckel, chief
Chemistry and Physics: W. T. Schaller, chief
Paleontology and Stratigraphy: J. B. Reeside, Jr., chief
Petrology: C. S. Ross, chief
Military Geology: E. S. Larsen, 3rd, acting chief
Geophysics: J. R. Balsley, acting chief

The Technical Service and Administrative Group includes the following units:

Manuscript Review Board: C. H. Dane, chairman
Geologic Map Editor: E. N. Goddard
Geologic Cartography: L. B. Pusey, chief
Committee on Geologic Names: Miss Frances Willoughby, secretary
Office of the Chief Clerk: Mrs. A. L. Brown, chief

Changes in field assignments have also been announced. A. L. Weissenborn, of the Rolla, Missouri, office, has been designated as regional geologist at Spokane, Washington. Robert A. Laurence has been made Eastern regional geologist, with temporary headquarters at Jefferson City, Tennessee. Charles B. Hunt, formerly chief of the Military Geology Unit, has been designated regional geologist at Salt Lake City.

NEWS FROM ABROAD

LETTER FROM DR. KARRE MÜNSTER STRØM

Dr. Karre Münster Strøm, head of the Department of Limnology of Oslo University, Norway, writes to Dr. Wm. Randolph Taylor that he and his colleagues have come through the war well, that he worked quietly at home most of the period, and that he hopes to pay the scientific visit to this country in 1946 that he had planned to take just before the war.

LETTER FROM DR. AAGE J. C. JENSEN

Dr. John E. Flynn, editor-in-chief of *Biological Abstracts,* writes that he has recently received a postal card from Dr. Aage J. C. Jensen, of the Kommissionen for Fiskeri- og Havundersögelser, which gives assurance that Dr. Jensen is in good health and that, though the activities of the Kommissionen for Fiskeriog Havundersögelser have greatly declined during the war years, there is prospect of their being resumed. Dr. Jensen's present address is: Charlottenlund Slot, Charlottenlund, Denmark.

LETTER FROM DR. W. AEG. TIMMERMAN

The director of the State Institute of Public Health, Utrecht, Holland, Dr. W. Aeg. Timmerman, has written as follows to the editor of SCIENCE:

During the war, from 1940 on, we have been completely devoid of all American literature. Money difficulties make it even now impossible to obtain American periodicals.

This most unsatisfactory situation continually increases our ignorance of modern scientific conceptions and technique. I would therefore be extremely grateful if authors of articles on microbiology, biochemistry, pharmacology, antibiotics, the manufacturing of sera and vaccines and on blood grouping, could send me some reprints of their work. This would be of very great help in our efforts to rebuild all that has been lost in recent years.

The American people have already given generous help to Holland: I hope, however, that I am not asking too much.

The address is: Director, State Institute of Public Health, Sterrenbosch 1, Utrecht, Holland.

I am, sir, yours faithfully,

LETTER FROM DR. F. VERDOORN

Dr. F. Verdoorn, managing editor of *Chronica Botanica* and botanical adviser to the Board for the Netherlands Indies, Surinam and Curaçao, writes that since his previous reports (SCIENCE, November 16 *et ante*) the death has been announced of the following biologists and agronomists in the Netherlands Indies:

Ir. J. H. Bos, chief forester of the Goenoeng Kidoel Forest, Jogjakarata.

Dr. H. Duyfjes, Jr., teacher in biology, Bandoeng.

Dr. R. F. A. Altman, chemist of the Rubber Research Institute, Buitenzorg.

Dr. A. d'Angremond, director of the Experiment Station Association Sumatra Rubber Growers, Medan.

Dr. J. D. F. Hardenburg, director, Laboratory for Marine Biology, Batavia.

Dr. Ir. Ch. Coster, director of the Experiment Station, West Java, Buitenzorg, formerly chief forester (executed July, 1943, by the Japanese).

According to word received from Singapore, Dr. M. A. Donk, mycologist of the Buitenzorg Botanical Gardens; Dr. G. Giesberger, microbiologist, and Dr. L. van der Pijl, known for his work on floral biology, are in Singapore, in relatively good health. R. E. Holttum, director of the Botanical Gardens of Singapore, is now in England; Dr. E. J. H. Corner is in charge of the gardens during his absence. Dr. M. R. Henderson, the curator of the gardens, who spent the war years in Newlands, South Africa, is on his way back to Singapore.

Of internationally known biologists in the Netherlands Indies it may be of interest to state that the following were alive last October:

At Buitenzorg:

Miss Dr. B. Polak, research associate, Institute of Soils, Genetics Agricultural Experiment Station.

Dr. D. F. van Slooten, chief of the Herbarium, Government Botanical Gardens.

Dr. H. J. Toxopeus, head of the Botanical Laboratory, Genetics Agricultural Experiment Station.

Dr. L. J. Toxopeus, entomologist, Zoological Museum.

M. A. Lieftinck, chief of the Zoological Museum.

Professor Dr. K. B. Boedijn, director of the College of Agriculture.

At Malang:

Dr. M. Hille Ris Lambers, geneticist, the Experiment Station Central and East Java.

News about the fate and whereabouts of Drs. Posthumus, van Steenis and van den Honert has already been published in SCIENCE.

LETTERS FROM DR. J. VAN DER BILT

Dr. Peter van de Kamp, director of the Sproul Observatory of Swarthmore College, has sent to us the following translation of letters, written in Dutch, received by him last summer while on a scientific mission in Paris. Since then he was in Holland, where he visited Dr. van der Bilt, lector emeritus in astronomy at the University of Utrecht, and found him and his wife well.

BAARN, 19 July 1945

. . . I had better not go into details about the horrible past five years and the deplorable condition of our destroyed and looted country. Practically everything must be built up anew, but there are no materials, raw or otherwise. Nevertheless a start has been made; yesterday, for the first time since Sept. '44, we received a small ration of electric current (9 kw for 60 days)[1] and on Sept. 1st there will be a little gas. Progress is very slow, but there is progress. My wife and I have come through all right, though we have become very thin and have aged much, especially after the railroad strike which induced the "Moffen"[2] to starve us. We lost about 25 kg weight, but did not have hunger oedema like so many others, among whom was Pannekoek. And since our liberation on May 5th we have already gained a few kg! Personally we had only one dangerous day, namely last

[1] Note by P.v.d.K.: Enough to burn one 50-watt lamp for three hours each night.

[2] An opprobrious name for the Germans used by the Dutch.

April 25, when Baarn was under British fire, but everything came off all right.

Nearly all intellectual work was stopped for months because of lack of current, of trains and also of time, because everyone had to toil daily for his food and fuel. None of the astronomers died, but the elder ones were certainly not benefited. Professor v. Rhyn was in Hellendoorn for a year with an acute case of T.B.; he is at home again but is not cured. Professor Hertzsprung recently has retired and Oort has become director. Minnsort was a hostage for two years; last winter he almost died as a result of making distant "hungertrips." But he is exceedingly tough. We are practically certain that we shall not see Pinkhof back. Of approximately 100,000 Dutch Jews an estimated 5,000 are alive; the others have been butchered in an atrocious manner, . . .

THE HAGUE, 22 July 1945

. . . Naturally all of us have become quite a bit thinner, but have kept alive on sugar beets and tulip bulbs. The latter, when boiled, taste like chestnuts. Not everyone can stand them, because they are slightly poisonous; this, however, can be corrected with some chalk. Toward the end we had no gas, no electricity, hardly any fuel, and had to cook on a sort of small emergency oil stove. Well, that is over now and we are already gaining some weight. The effect of lack of protein is remarkable; it causes a noticeable lack of memory. Our staff was much bothered by that; however, it does not seem to be lasting; after good nourishment it returns. To keep myself in shape I had stored up some casein, which proved quite helpful. . . .

On November 28, 1945, Dr. van der Bilt received the sad news of death through exhaustion as Japanese prisoners in the Netherlands East Indies of the following Dutch astronomers:

Dr. Arnout de Sitter, acting director of the Bosscha Observatory at Lembang, Java.

Dr. W. Chr. Martin, Bosscha Observatory.

Mr. J. Uitterdyk, teacher in Batavia.

SCIENTIFIC NOTES AND NEWS

DR. JOSEPH L. ROSIN, pharmaceutical chemist of Plainfield, N. J., was presented on December 11 with the 1945 Remington Medal of the New York branch of the American Pharmaceutical Association in recognition of his work as "the foremost American authority on chemical reagents." The medal was presented at a dinner meeting at the Hotel Pennsylvania, attended by leading representatives of professional and scientific pharmacy.

AT the annual meeting in New York City of the American Pharmaceutical Association the Award for Scientific Distinction was presented by Dr. Alan Valentine, president of the University of Rochester, to the Rockefeller Institute for Medical Research. It was accepted by Dr. Homer T. Swift, acting director of the hospital of the Rockefeller Institute, who read an address by Dr. Herbert S. Gasser, director of the institute, who was unable to be present.

THE second presentation of the Elizabeth Severence Prentiss Award in health education was made to Dr. C.-E. A. Winslow, Lauder professor emeritus of public health of the School of Medicine of Yale University, at the Cleveland Health Museum, which celebrated on November 27 its fifth anniversary with a civic luncheon at which the attendance was about five hundred.

THE Achievement Medal of the Florida Academy of Sciences (Phipps and Bird, Richmond, Va., donor) was awarded to Garald G. Parker, geologist of the U. S. Geological Survey, Ground Water Division, of Miami, Fla., at the meeting in St. Augustine of the academy on December 6 and 7. The title of his paper was "The Effect of the Pleistocene Epoch on the Geology and Ground Water of Southern Florida."

AT a dinner given on November 28 in honor of the seventy-first birthday of Dr. Chaim Weizmann, he was presented with a check for $1,000,000 to be used for the establishment of the Weizmann Institute of Science in Palestine.

PHI LAMBDA UPSILON, the honor society for men in chemistry, announces the election of the following officers to serve for the coming triennium: *President,* Dr. T. F. Buehrer, of the University of Arizona; *Vice-president,* Dr. L. F. Audrieth, of the University of Illinois; *Secretary,* Dr. James M. Church, of Columbia University; *Treasurer,* Dr. Herschel Hunt, of Purdue University; and *Editor* of *The Register,* Dr. Robert D. Vold, of the University of Southern California.

DR. HANOR A. WEBB, head of the department of chemistry of George Peabody College for Teachers, Nashville, was elected president of the Tennessee Academy of Science at the business meeting on December 1. Dr. Paris B. Stockdale, head of the department of geology at the University of Tennessee, Knoxville, was elected vice-president. Kendall E. Born, of the State Division of Geology, Nashville, was re-elected secretary-treasurer.

DR. W. B. YOUNG, acting dean of agriculture at the University of Connecticut, has been appointed dean of the College of Agriculture and director of the Experiment Station. Dr. W. L. Slate will again become vice-director.

COMMANDER C. M. LOUTITT, who has been commanding officer of the Service School Command, Naval Training Center, Bainbridge, Md., has been released to inactive duty. He has been appointed professor of psychology at the Ohio State University and is assuming direction of the work in clinical psychology.

DR. ROBERT P. SHARP, who is now on terminal leave from the Army Air Corps, where he has served as an expert on glaciology in the Arctic Information Center, at the beginning of the winter term will take over his work as associate professor of geomorphology and glaciology at the University of Minnesota.

DR. SHERWOOD K. HAYNES has been appointed associate professor of physics at Vanderbilt University. He was recently associate director of the Radar School of the Massachusetts Institute of Technology. Dr. Philip Rudnick has been promoted to a professorship of physics and will return to his work there on January 1.

DR. JOSEPH C. SHAW, assistant professor of dairy husbandry at the University of Connecticut, has become professor of dairy husbandry at the University of Maryland.

DR. R. DALE SMITH, head of the department of biology at Gonzaga University, Spokane, Wash., has been appointed assistant professor in the department of anatomy of the School of Medicine of the University of Maryland, Baltimore, effective, January 1.

DR. E. MONROE BAILEY, since 1902 associated with the work in chemistry of the Connecticut Agricultural Experiment Station at New Haven, since 1917 chief of the department of analytical chemistry, a recognized authority on food and drug standards, retired on October 1. Dr. Harry J. Fisher, associate chemist, has been appointed acting head of the department.

THE Committee on International Cooperation in Anthropology, Division of Anthropology and Psychology, National Research Council, has undertaken the task of gathering information concerning the status of anthropological personnel, scientific societies, museum and university departments, and publications, in countries affected by the war, and is reporting its findings in a series of communications in *The American Anthropologist*. The first one of these, on France, appeared in the October–December, 1945, issue; the second, on Scandinavia, will be forthcoming in the January–April number. The personnel of this committee is Dr. Henry B. Collins, Jr., Dr. John M. Cooper, Dr. William N. Fenton, Dr. Henry Field, Dr. Frederica de Laguna, Dr. Robert H. Lowie, Dr. William Duncan Strong, Dr. Franz Weidenreich and Dr. Melville J. Herskovits, *chairman*. It will be appreciated if any information concerning anthropology or anthropologists could be communicated to the chairman (Department of Anthropology, Northwestern University, Evanston, Illinois), for incorporation in these accounts.

A NEW YORK STATE SCIENCE SERVICE has been established as a new agency of the State Museum at Albany, N. Y., of which Dr. Carl E. Guthe is director, to serve as a clearing house and advisory center for the dissemination of impartial scientific information to schools and other agencies. The service will be conducted by a staff of State scientists and their assistants on the museum staff, including Dr. Winifred Goldring, paleontologist; Dr. Robert D. Glasgow, entomologist; Dr. Homer G. House, botanist; Noah T. Clarke, archeologist; Dr. John G. Broughton, assistant geologist; Walter J. Schoonmaker, assistant zoologist, and Kenneth F. Chamberlain, assistant entomologist.

DR. A. MCGEHEE HARVEY, Army major, U.S.A., on terminal leave, has been appointed director of the Department of Medicine and physician in chief of the Johns Hopkins Hospital, Baltimore. He will take up his work on June 30. He succeeds Dr. Warfield T. Longcope.

DR. HART E. VAN RIPER, pediatrician, formerly of Madison, Wis., has been appointed assistant medical director of the National Foundation for Infantile Paralysis.

A COMMITTEE of inquiry and research on atomic energy of thirty-five members has been appointed by the Carnegie Endowment for International Peace. Members of this committee include Dr. Karl Compton and Dr. Harold Urey.

FACULTY members of the Michigan College of Mining and Technology who have recently returned from service with the armed forces include Lieutenant Commander R. W. Drier, associate professor of metallurgical engineering; Lieutenant Chester Pratt, USNR, and Captain Thomas Vichich, U.S.A., instructors in mathematics. Captain H. W. Risteen and Commander Jerry Service, of the United States Naval Reserves, associate professors of mechanical engineering and of physics, respectively, will return for the winter term.

DR. KARL COHEN, formerly associated with Columbia University, where he worked on its atomic research project, has joined the staff of the Standard Oil Development Company. He will later work at the new laboratory to be constructed at Linden, N. J.

DR. HARLOW SHAPLEY, director of the Harvard College Observatory and national president of the Society of Sigma Xi, spoke at the University of California, Los Angeles, on the afternoon of December 7. His subject was "Planetary Perplexities." On the evening of December 8, he delivered the final address of a two-

day "Conference on American-Russian Cultural Exchange," sponsored at the university jointly by Phi Beta Kappa and the Society of the Sigma Xi. The latter address, at which Dr. Robert A. Millikan, of the California Institute of Technology, presided, was entitled "Planetary Worries, Science and Peace."

DR. R. SMOLUCHOWSKI, research physicist at the Research Laboratory of the General Electric Company, Schenectady, N. Y., delivered the opening lecture on November 16 before the Sigma Xi Chapter of North Carolina State College. The title of his lecture was "Inaudible Sounds."

THE twenty-seventh National Metal Congress and Exposition will be held in the Public Auditorium of Cleveland during the week of February 4. An attendance of more than 30,000 is expected. In addition to the technical program of the American Society for Metals, papers will also be presented by the American Industrial Radium and X-Ray Society, meeting at Hotel Hollenden on Wednesday, Thursday and Friday, February 6, 7 and 8. Other societies will have business or group meetings during the week. Presentation of four medals will be a feature of the annual dinner on February 7: the Henry Marion Howe Medal for the paper of the highest merit published in *Transactions* during the year 1944, the Albert Sauveur Achievement Award, the American Society for Metals Medal for the Advancement of Research and the American Society for Metals Gold Medal.

THE American Society of Zoologists, in conjunction with Section F of the American Association for the Advancement of Science and in association with other biological societies, will hold its next meeting in Saint Louis on March 28, 29 and 30, 1946. The preliminary announcement and call for papers will be issued in the near future by the Secretary, Dr. L. V. Domm, The University of Chicago. Titles and abstracts must be received not later than February 1.

THE National Research Council announces that the closing date for applications for the predoctoral fellowships in the natural sciences, which it is administering under a grant from the Rockefeller Foundation, will be February 1, 1946. These fellowships, as announced in September, are to assist young men and women, whose graduate training in the natural sciences was prevented or interrupted by their war activities, to complete their work for the doctorate. Candidates should send in their applications at once, and —in any case—prior to February 1, 1946, even though they may be unable to begin their graduate work until a later date. Information concerning the fellowships and nomination-application blanks have been mailed out widely to graduate schools and wartime research laboratories. They may also be obtained by writing directly to the Secretary, Committee on Predoctoral Fellowships, National Research Council, 2101 Constitution Ave. N.W., Washington 25, D. C.

NON-POLITICAL control of proposed Federal aid to scientific research was urgently requested at a recent meeting of the New York Section of the American Chemical Society, representing more than 4,000 chemists and chemical engineers. The Magnuson bill for a Federal program directed by outstanding scientists and laymen was endorsed; the Kilgore bill, putting the entire project under a single director, was opposed. A resolution passed by the section approved without reservation the principles expressed in a recent letter to President Truman, signed by forty-three leading scientific men, which supported the Magnuson bill and called for the establishment of a national research board of experts appointed by the President without reference to political affiliation.

IN the interest of the more rapid development of jet propulsion and rocketry in the United States the American Rocket Society has become affiliated with the American Society of Mechanical Engineers.

THE Florida Academy of Sciences, in annual meeting assembled at St. Augustine, on December 6 and 7, by resolution endorsed the Bowman open letter to President Truman (SCIENCE, November 30) and so wired the President. Copies of the telegram were sent to thirty-six members of the Congress, committee members and those representing the State of Florida.

THE fiftieth anniversary of the General Electric Engineering and Consulting Laboratory at Schenectady, N. Y., was observed on November 13. Speeches were made by A. L. Rohrer, the founder; E. S. Lee, successor to the late Dr. "Louie" T. Robinson, and Dr. E. F. W. Alexanderson. Later in the year a bronze plaque, now being made, will be unveiled in the laboratory.

THE centenary celebrations of the Imperial College of Science and Technology, South Kensington, was held on October 22, when a message from the King of England was broadcast from the Royal Albert Hall. The Imperial College is a federation of the Royal College of Science, the Royal School of Mines and the City of Guilds College. These were related to earlier institutions, the first of which, the Royal College of Chemistry, was founded a century ago. In 1907, by a Royal Charter of Incorporation, the three colleges were joined together and established as a school of the University of London.

THE Percy Committee in its report on Higher Technological Education, published by the British Ministry of Education, includes the following recom-

mendations: The establishment of eight Regional Advisory Councils in England and Wales to coordinate technological studies in universities, colleges of technology and other technical institutions (each council should establish an academic board to ensure coordination on the teaching level and there should be arrangements for adequate representation of and consultation with industry on both the council and the board); the establishment by the Minister of Education of a standing organization to be known as the National Council of Technology to advise on national aspects of regional policy; the selection of a limited number of colleges as colleges of technology to provide full-time courses, as well as facilities for post-graduate studies. For engineering, about six colleges are suggested, excluding the London area; additional institutions might be selected for other branches of technology.

THE trustees of the late Sir William Napier Shaw, F.R.S., who was director of the British Meteorological Office, have offered to the University of Cambridge his meteorological library, together with an endowment of between £5,000 and £6,000 for its upkeep and for the development of the "study of the atmosphere."

SPECIAL ARTICLES

FURTHER STUDIES ON THE MONKEY ANTI-ANEMIA FACTOR[1]

WE have recently reported[2] that whole liver powder contains a factor necessary for optimum growth and blood production in monkeys maintained on purified diets. An assay for this factor depends upon a measure of the weight and hemoglobin response in a monkey that has failed to show a complete recovery from a riboflavin deficiency after riboflavin therapy. Subsequent experiments have demonstrated that brewer's yeast fed at a level of 8 per cent. in the ration was an inadequate source of this factor. Scott *et al.*[3] reported that beta-pyracin had hemopoietic properties for chicks when fed with a source of the *Lactobacillus casei* factor; however, we have found that a combination of these two factors was ineffective for the monkey.

TABLE 1

THE RESPONSE OF STANDARDIZED ASSAY MONKEYS TO FRESH AND LYOPHILIZED LIVER THERAPY

Monkey No.:	82		164		53		125	
Treatment:	10 grams fresh pork liver per day for one week				3 grams lyophilized liver per day for one week			
	Before	After	Before	After	Before	After	Before	After
Weight (grams)	3800	3995	2770	2910	4870	5180	3070	3300
Hemoglobin (grams/100 cc)	11.71	14.28	12.06	13.89	12.13	14.67	11.05	14.03
R.B.C. (millions/c.m.m.)	3.00	4.30	3.10	4.20	3.05	4.85	2.85	4.67

Two assay monkeys were fed fresh pork liver in order to determine whether fresh liver is a more potent source of the active principle than whole liver powder. Livers obtained directly from the packing plant were thoroughly ground and stored in a frozen condition. Ten grams of this liver mixed with the dry ration were fed to each monkey per day. This level corresponds to about 3 per cent. whole liver powder in the entire diet. The two monkeys showed a definite gain in weight and hemoglobin production during the following week (*cf.* Table 1). Since it requires an average of 3 weeks to produce a maximum response when whole liver powder at a level of 3 per cent. in the diet is fed it is evident that fresh pork liver is a more potent source of the monkey anti-anemia factor than whole liver powder.

Further assays with fresh beef liver showed it to be as active as fresh pork liver. However, some difficulty was encountered in feeding these fresh liver preparations and therefore lyophilized liver was tried. The liver was lyophilized by freezing with dry ice and then drying under high vacuum. The product thus obtained powdered easily and mixed well with the dry ration. It was stored in a stoppered container in the refrigerator.

Two assay monkeys were given 3 grams of the lyophilized liver daily mixed with the dry ration. Here again an increase in weight and hemoglobin content of the blood was evident within a week, as is shown in Table 1. Since the lyophilized liver had about the same effect as an equivalent amount of fresh liver it can be readily seen that no loss in activity occurs when this method of drying is employed. Both fresh liver and lyophilized liver contained more of the monkey anti-anemia factor than equivalent amounts of whole liver powder indicating that ordinary methods of drying destroy appreciable amounts of the activity of liver.

Since this factor is so labile special precautions must be taken during fractionation and isolation procedures.

[1] Published with the approval of the director of the Wisconsin Agricultural Experiment Station. Supported in part by grants from the National Foundation for Infantile Paralysis, Inc., New York, and the Commercial Solvents Corp., Terre Haute, Indiana.

[2] J. M. Cooperman, H. A. Waisman, K. B. McCall and C. A. Elvehjem, *Jour. Nutrition*, 30: 45, 1945.

[3] M. L. Scott, L. C. Norris, G. F. Heuser and W. F. Bruce, *Jour. Biol. Chem.*, 158: 291, 1945.

SUMMARY

Fresh liver was found to be a more potent source of the monkey anti-anemia factor than whole liver powder. Beef and pork livers had equal potency. Lyophilized liver retained all the active principle of fresh liver.

JACK M. COOPERMAN
KEITH B. MCCALL
C. A. ELVEHJEM

DEPARTMENT OF BIOCHEMISTRY,
COLLEGE OF AGRICULTURE,
UNIVERSITY OF WISCONSIN

DEMONSTRATION OF INFLUENZA VIRUS, TYPE B, IN A RECENT OUTBREAK OF UPPER RESPIRATORY INFECTION[1]

THERE are only a few published reports on the isolation of Type B influenza virus in this country.[2,3,4,5,6] We have recently (May, 1945) isolated a strain of influenza B virus from an outbreak of upper respiratory infection at Camp Atterbury, Indiana.

The outbreak was rather mild and well isolated in its case distribution within an area of the camp. The virus was detected in the second egg passage carried out by the method described by Hirst.[7] In making the passage the tracheas of injected embryos were ground and suspended in pooled allantoic fluid from the same eggs. The identity of the virus was established by means of the red blood cell agglutination-inhibition test,[8] using sera from chickens immunized against the Type A (PR8) and Type B (Lee) viruses.[9] The new strain was named "Saha." Table 1

TABLE 1

ANTIGENIC STUDY ON SAHA VIRUS RBC AGGLUTINATION-INHIBITION TESTS

Virus	Sera produced against:		
	Lee	Saha	PR8
Lee	800*	320	< 400†
Saha	160	1,280	< 400
PR8		<80	12,800

* Expressed as the reciprocal of the agglutination-inhibition titer.
† Titrated by Salk's method.

is representative of a number of tests on the antigenic nature of the Saha virus. It is apparent that the virus in question is antigenically related to but not identical with the Lee virus, and it has no common antigen with the Type A (PR8) virus.

To date the virus has been passaged nine times in chicken embryos by the allantoic route of inoculation. In line with the experience of other workers who have studied recently isolated strains of influenza B, we have found it somewhat difficult to maintain this virus in a limited series of mouse lung passages.

A study of acute and convalescent sera of patients was made by means of the red blood cell agglutination-inhibition test. All sera were examined by the Hirst method,[8] and some were also tested by the method described by Salk.[10] The paired serum specimens were received in three groups submitted at successive intervals after the onset of the epidemic. Although some paired specimens had relatively high titers against the PR8 virus, none showed an increase in antibody titer in comparative tests on acute and convalescent sera. In group I of 23 paired specimens, 12 (52 per cent.) had a significant increase in titer of four-fold or higher against the Lee virus and 17 (74 per cent.) showed a similar increase in titer against the Saha virus. On comparing the titers in group II of nine paired serum specimens, 8 (89 per cent.) had a significant increase in antibodies against both the Lee and Saha strains of virus. In group III of 15 paired specimens, 14 (93 per cent.) again demonstrated a significant rise in antibody titer against the two strains. These serological results furnish additional evidence that the outbreak was due to a Type B virus.

This localized epidemic in the late spring of this year (1945) may be of significance, especially in view of the reported slight increase in influenza in this country (*Public Health Reports*), which began in the week ending May 12th, compared with the incidence in the same week in 1944 and the median for 1940–1944. Although the outbreak referred to herein may remain an isolated episode, the possibility exists that it may represent the beginning of an epidemic wave of Type B etiology. The situation may parallel the experience of 1943, when an epidemic of influenza Type A was preceded by a localized outbreak of influenza in an Army camp, from which Salk, Menke and Francis[11] isolated a Type A virus.

M. M. SIGEL,
1st Lt., SnC
M. M. HART
G. HOBBS,
T/Sgt.
B. GUTHNER

[1] From the Virus Section, Fifth Service Command Laboratory, Fort Benjamin Harrison, Indiana.
[2] T. Francis, Jr., SCIENCE, 92: 405, 1940.
[3] T. P. Magill, *Proc. Soc. Exp. Biol. and Med.*, 45: 162, 1940.
[4] M. D. Eaton and M. D. Beck, *Proc. Soc. Exp. Biol. and Med.*, 48: 177, 1941.
[5] I. Gordon, *Jour. Imm.*, 44: 231, 1942.
[6] C. Nigg, C. M. Eklund, D. E. Wilson and J. Crowley, *Am. Jour. Hyg.*, 35: 265, 1942.
[7] G. K. Hirst, *Jour. Imm.*, 45: 293, 1942.
[8] G. K. Hirst, E. R. Rickard, L. Whitman and F. L. Horsfall, *Jour. Exp. Med.*, 75: 495, 1942.
[9] N. P. Hudson, M. M. Sigel and F. S. Markham, *Jour. Exp. Med.*, 77: 467, 1943.
[10] J. E. Salk, *Jour. Imm.*, 49: 87, 1944.
[11] J. E. Salk, W. J. Menke and T. Francis, Jr., *Jour. Am. Med. Asn.*, 124: 93, 1944.

TRANSMISSION OF THE TOXICITY OF DDT THROUGH THE MILK OF WHITE RATS AND GOATS

To determine if DDT[1] (or its decomposition products) is eliminated in the milk of animals, a mixture of 0.1 per cent. DDT in a balanced chicken mash was fed to 3 young female rats, each with a one-day old litter. Typical tremors were noted in the mother rats between the 6th and 13th days and in their young between the 14th and 15th days. By the 18th day all were dead except one adult and one nursling, which were then placed on a normal diet and apparently recovered. Evidence was thus obtained that the toxic principle was transmitted through the mothers' milk, since the young showed toxic symptoms before weaning.

Nine adult rats fed solely on a diet of goats' milk obtained from animals receiving daily oral dosages of 1 gram of DDT per 8 to 9 pounds body weight, died within 2 to 29 days exhibiting typical DDT symptoms. While individual differences in the animals may have accounted in part for this wide range in toxicity, the length of time the goats were under treatment before the milk was administered to the rats was probably more important. Milk obtained from goats having received these dosages from 21 to 26 days was much more toxic than milk obtained from animals subjected to shorter periods of treatment. For example, 5 of the rats died between 2 to 5 days and in each instance the first milk which they received was from goats under treatment from 21 to 23 days.

In one trial, toxic goats' milk fed to a recently parturient rat produced symptoms in her on the 21st day and in the young on the 24th. In a similar trial, toxic milk fed to a female rat with a 12-day-old litter produced typical symptoms in the mother on the 2nd day and in the young on the 3rd day. Therefore, the toxic principle, which was secreted in goats' milk, was transmitted to nursing rats through the milk of the mother rat.

Milk obtained from a goat 24 hours after the oral dosages had been discontinued, when fed to 2 adult rats produced tremors on the 2nd day and death occurred in one subject on the 3rd day. The remaining rat steadily improved on the same diet and apparently recovered. A similar trial on 2 adult rats given milk 48 hours after the treatment of the same goat had been discontinued produced no toxic symptoms.

A half-grown kitten given milk from a goat, which had been under treatment for 25 days, died with typical DDT symptoms within 3 days. Young goats may be more tolerant to this milk, for no harmful effects were noted in an unweaned kid allowed to suckle *ad lib.* a goat under treatment for 27 days.

There is evidence that the toxic principle is concentrated in the fat globules of the milk, for butter, prepared from the milk of goats under similar treatment, when fed to rats produced typical tremors in the latter within 24 hours. No experiments were undertaken, however, to determine if other constituents of milk were toxic.

Frequent administration of DDT suppressed milk secretion in goats; consequently, lactation generally ceased between the 21st and 28th day of dosing. Some animals showed no toxic symptoms, and all those which received DDT recovered; yet their milk contained enough of the toxic substance to produce symptoms in rats. Since the milk apparently became more toxic after an extended period of treatment, two theories of explanation are advanced: either the toxic substance was eliminated in the milk in ever-increasing amounts or possibly similar amounts of poison were eliminated daily but became more concentrated as the milk supply diminished.

Since Smith and Stohlman[2] as well as Draize *et al.*[3] showed DDT to be absorbed through the skin of laboratory animals, the possibility of obtaining toxic milk from animals sprayed with the compound was studied. Goats were chosen in preference to cattle for the experiment largely because they are not in the habit of licking themselves, thus eliminating this risk of extraneous oral ingestion. Milk obtained from a 103-pound goat receiving 150 cc once daily of a 10 per cent. DDT emulsion as a spray and fed to rats produced no toxic symptoms in the latter in 42 days. A young kid allowed to suckle this sprayed animal for 76 consecutive days showed no ill effects.

These preliminary observations prove that with continued oral administration of DDT to goats and rats, there is eliminated in their milk a toxic substance which produces symptoms indistinguishable from DDT intoxication. The data strongly suggest the need for more intensive research on the toxicity of milk from dairy cows ingesting DDT residues either from sprayed or dusted forage plants or from licking themselves after being sprayed or dusted with this insecticide.

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[1] (1-trichloro-2,2-bis(*p*-chlorophenyl)ethane).

[2] M. I. Smith and E. F. Stohlman, *Public Health Reports*, 59(30): 984–993, 1944.

[3] John H. Draize, Arthur A. Nelson and Herbert O. Calvery, *Jour. Pharm. and Exp. Ther.*, 82(2): 159–166, 1944.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A "FOG" OR AEROSOL APPLICATOR FOR DDT

HAVING recently (mid-August) observed a second series of experiments, in the Salt River Valley of Arizona, on application of DDT in an oil fog, we wish to record the method. For the first experiments during April, 1945, the U. S. Navy's "fog generator," then a secret weapon, was released for experimental purposes to Colonel Dale Bumstead, of Tal-wi-wi Ranch, Peoria, Arizona, to be under direction of the authors, acting for the Arizona Agricultural Experiment Station. This generator, manufactured by the Todd Shipbuilding Corporation of New York, produces a remarkable white opaque fog from oil. Since DDT is oil-soluble it was conceived that the fog generator might be readily adapted to peace-time use as an insecticide applicator. Representatives of the manufacturers accompanied the equipment and, during a series of tests and field demonstrations, made and conceived various modifications to produce a more satisfactory fog for the application of DDT in insect pest control work.

The fog best adapted to concealment (the original purpose) is too fine and light for best results in insecticide applications in the field. It billows and rises to heights far greater than required, but does leave a remarkably fine and uniform deposit of minute crystals of DDT on all surfaces of the plants "fogged." Application is rapid. Results of the first experiments on grape leafhopper and on livestock pests and some of the comments of visiting entomologists are set forth in our Mimeographed Report No. 75.[1] Later checks have fully borne out the results therein reported.

Following the spring experiments, the Todd engineers continued their tests, and have now evolved a new machine, specifically for production of insecticidal fog for insect pest control. This machine, while entirely different in appearance from the Navy's generator, uses the same principle in breaking up the insecticidal oil into a fog which has better characteristics for application to field crops and livestock than the obscuring fog for military purposes. The "particle size" is greater, giving a heavier but less opaque fog which, however, deposits the insecticide in a remarkably uniform manner on all surfaces.

Certain simple mechanical changes in the discharging vents have adapted it to better initial distribution from the machine into the crop to be treated. Preliminary checks immediately after the most recent tests indicate better control than in the earlier experiments.

This is, practically, aerosol production on a field scale, and we believe it is destined to rank high as a method of application of insecticides in pest control work. Its adaptability to other than oil-soluble insecticides is yet to be determined.

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ACETONE CO_2 BATHS

THE following statement may be of interest to laboratory workers who have occasion to use acetone-CO_2 baths for low temperature work:

Acetone-CO_2 baths commonly used to cool low temperature receivers present a certain hazard as a result of their tendency to foam. Foaming may be due to too fast addition of CO_2 in preparing the bath, warming of the receiver during distillation, accidental bumping of a CO_2-supersaturated bath and many other causes. Open flames in the vicinity may cause bad fires.

It has been noted in these laboratories that foaming is markedly reduced if a few drops of silicone fluid or a small piece of silicone stopcock grease is added to the bath. As the stopcock grease (advertised as Dow Corning Stopcock Grease) is available at most of the chemical supply houses it would likely be the more convenient material for use in most laboratories. One application should last indefinitely, provided the Dewar flask is not washed out.

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DISCUSSION

NOMENCLATURE OF PROTEOLYTIC ENZYMES

THE nomenclature of certain groups of proteolytic enzymes is in an unsatisfactory state at present and is in need of reform. While this difficulty arises to some extent from a lack of knowledge of the nature and mode of action of these enzymes, it is also due in part to an unfortunate tendency to name different groups of proteinases after representative members. Thus enzymes with optimum activity in acidic solution

[1] Charles T. Vorhies and Lawrence P. Wehrle, "Preliminary Tests of DDT Applications to Crop Plants and Livestock with Navy's Fog Generator."

or with specificities similar to that of pepsin are called "pepsinases." Similarly, enzymes which resemble papain in their activation and inhibition behavior are called "papainases."

In a recent review[1] it was urged that the designations for proteinases be as descriptive as possible of the *properties* of the enzymes. For instance, the terms "acidoproteinase," "neutroproteinase" and "basoproteinase" were suggested to indicate the pH region of optimum activity.

The proteinases of the higher plants appear to fall into two classes. One group includes such enzymes as papain, ficin and bromelin. These enzymes can be reversibly inactivated by mild oxidation and then reactivated by certain reducing agents. The name *anastrophic* (αναστροφη = reversal) is suggested for this group as being descriptive of this characteristic behavior. A second group is represented by solanain, hurain and arachain. Inasmuch as these enzymes are unaffected by either oxidizing or reducing agents, it is proposed that they be termed *stasidynic* proteinases (στασιμος = stationary, δυναμις = activity).

THEODORE WINNICK
DAVID M. GREENBERG

OCTOBER 16, 1945

SOVIET BIOLOGY

IN his recent report on Soviet Biology[1] Dr. Zhebrak assures us that "the careers of *many*[2] Soviet geneticists have not been adversely affected by the above-mentioned [Vavilov-Lysenko] controversy." If, as Zhebrak claims, Lysenko's "influence has been exerted in open debate between proponents of different scientific views and principles and not by political pressure" why should the career of any Soviet geneticist be so "adversely affected"? Of the three geneticists specifically mentioned in my original article Dr. Zhebrak accounts for only one. What has happened to Karpechenko, the geneticist who laid the foundation for work on allopolyploid hybrids which Zhebrak has developed so successfully? Where is Vavilov, one of Russia's greatest scientists and one of the world's greatest geneticists? Vavilov was elected president of the International Genetics Congress which met in Edinburgh in 1939, but Vavilov did not attend, and we have not heard from him since. We now have information from our National Academy of Sciences that Vavilov is dead. How did he die and why?

The American geneticists have long recognized the valuable work done in the Soviet Union and have enjoyed the most cordial personal relationships in the past, but even before the war it was difficult to maintain personal contacts. No Soviet scientists attended the International Botanical Congress in Amsterdam in 1935 or the International Genetics Congress in Edinburgh in 1939. Perhaps lack of funds kept them at home, but China and India were represented. Isolationism in science, or in any other field, has no place in a modern world. We hope that we may soon resume communication and personal association with our Russian friends and colleagues.

KARL SAX

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SCIENCE LEGISLATION

IN the November 30 issue of SCIENCE an article appeared on "Pending Legislation for Federal Aid to Science." It contains a letter to the President with 43 signatures of scientists and is followed by an endorsement of the principles embodied in the letter signed by R. Chambers and J. S. Nicholas on behalf of the executive committee of the Union of American Biological Societies and the American Biological Society.

Since this publication, attention has been called to an impression given by the letter to the President of an uncompromising attitude in regard to the administrative set-up that was recommended for the National Science Foundation. The letter specifically endorses the proposal of the Magnuson Bill, *viz.*, that the foundation be administered by a board of scientists appointed by the President. This form has the approval of a large number of scientists throughout the country and the consensus of opinion seems to be that, for fundamental scientific research, this is the best method of administration. The impression that the letter is uncompromising is unfortunate and should not be considered as such.

There are, at present, two proposals—one advocated by Senator Kilgore, the other by Senator Magnuson. The one differing from what has been presented above advocates a full-time administrator appointed by the President. Thus, we may consider two divergent viewpoints—one, a board appointing its own administrative officer, and the other, a director with an advisory board. If a mutually acceptable decision is not reached, the chances of a realization of a Federal Research Foundation are likely to be seriously jeopardized.

The present is the psychological time for securing a National Science Foundation. The telling experience of the war is fresh and has made the country very aware of science. Congress is reflecting this attitude in the consideration of various proposals for science legislation. The Bush Report, the President's message of September 6, and the four volumes of

[1] D. M. Greenberg and T. Winnick, *Ann. Rev. Biochem.*, 14: 31, 1945.

[1] A. R. Zhebrak, SCIENCE, 102: 357–358, October 5, 1945.

[2] Italics mine.

testimony of the joint hearings have all supported the vital need of a National Science Foundation. Moreover, a poll of the American Association for the Advancement of Science in September showed that 90 per cent. of the scientists of the country want legislation for a Federal Science Foundation.

A revision of the Kilgore and the Magnuson Bills is expected, advantage being taken of the hearings held in Washington. A joint bill is to be hoped for which will embody the best and most workable features of both.

We stand ready to cooperate fully and freely in the drafting of a bill which will effectively serve the objectives which the foundation is intended to achieve.

On behalf of the Joint Executive Committees of the Union of American Biological Societies and the American Biological Society,

ROBERT CHAMBERS, *President, Union of American Biological Societies*
J. S. NICHOLAS, *President, American Biological Society*

SCIENTIFIC BOOKS

ASTRONOMY

Astronomy; A Revision of Young's Manual of Astronomy. Vol. 1, *The Solar System.* By HENRY NORRIS RUSSELL, RAYMOND SMITH DUGAN and JOHN QUINCY STEWART, Editors. Illustrated. xi + 470 + xxi pp. Ginn and Company. 1945. $3.00.

THIS volume constitutes a revised edition of Part 1, "The Solar System," being the first of two volumes on "Astronomy" initially published in 1926. The rapid advance of astronomy in the last twenty years has called for a revision of this outstanding text. A superficial comparison of the present book with the earlier edition reveals essentially the same text and subject-matter page for page. A careful comparison of the new with the old edition, however, shows many changes and additions made necessary by current progress.

This book, as the 1926 issue, is based on C. A. Young's "Manual of Astronomy," published in 1902. The present volume comprises 470 pages devoted to the fundamentals of astronomy, astronomical instruments, the earth, the sun, the moon, planets, comets and meteors.

Among newer and additional topics not covered in the earlier edition may be mentioned the Schmidt camera, the small effect of the variation of latitude on longitude, extension of the use of gravity measurements to belts of deficiency and excess as in the island arcs of the East and West Indies, a revision and extension of the treatment of the age of the earth and its early history, the new determination of the moon's mass derived by H. Spencer Jones from observations of Eros, the new value of the solar parallax, the mention of the connection of sunspots with radio transmission, more recent data from eclipse observations on the Einstein effect, the contribution of Adams and Dunham and others to a better knowledge of the atmosphere of the planets, the discovery of Pluto, new material on comets and meteors, and a summary of newer theories on the origin of the Solar System.

It is remarkable that so much of the book could have been changed without more interference with the original pagination. This has been accomplished in many instances by the deletion of some material, the omission of a few illustrations and by taking advantage of the unused space at the end of several chapters in the earlier edition. The reader finds certain omissions of topics which could have been logically hoped for in so comprehensive and standard an authority on astronomy.

In the chapter on astronomical instruments, no attention is given to the photozenith tube (PZT), the latest development in the precise determination of latitude at the U. S. Naval Observatory. In the discussion of longitude by radio or wireless signals, the velocity of transmission time based on the 1913–14 longitude campaign between Paris and Washington is given as 175,000 miles per second, "which agrees within the (large) experimental error with that of light." No mention is made of investigations showing observed differences in the velocity of radio waves with (geomagnetic) latitude, yielding results varying from sensibly the velocity of light at the equator to only two thirds the velocity of light at the region where radio transmission paths approach the north magnetic pole. In the treatment of the calendar, one looks in vain for a mention of proposed calendar reform with an evaluation of the major schemes now under international consideration.

In the chapter on the sun, it is unfortunate that the authors did not revise the curve of sunspot numbers and geomagnetic activity to include more recent data than that of the 1920's. The importance of solar activity in establishing wave-lengths or frequencies for all long-distance radio communication deserves a more extended treatment than the half-sentence devoted to it, "magnetic storms are accompanied by serious disturbances of long-range radio transmission." The close dependence of usable frequencies

upon the sunspot curve has long been recognized by radio engineers and would appear to be irrefutable. The remarkable fadeouts in radio reception at all frequencies on the sunlit half of the earth which occur simultaneously with solar explosions, or flares, could well have been mentioned, since the student of to-day is becoming more and more consciously aware of cosmic factors in communication conditions. It may be noted that the authors apparently prefer the now obsolescent form in spelling "sun-spots" with the hyphen, although current literature and modern editions of Webster give little justification for the hyphenated form.

The slight mention in a book of astronomy of possible relations between the solar cycle and meteorological conditions is encouraging. Because of the practical implications involved, some mention could well have been made of the apparent changes in distribution of atmospheric pressure over the globe with the sunspot cycle, an effect more pronounced than the small temperature differences to which the authors appear to subscribe.

The rapid advance in highly specialized fields in all branches of science has made more and more difficult the writing of and also the finding of generally comprehensive text-books on the basic sciences. Astronomy, probably the oldest of the sciences, has a delightful way of interpenetrating many fields from geodesy and geophysics to atomic structure and even radio engineering. The authors have done a valuable service in revising Volume 1, and one can anticipate that the revision of Volume 2, covering the stars and astrophysics, will contain even greater changes upon its appearance.

HARLAN T. STETSON

THE STUDY OF HUMAN BEHAVIOR

Developmental Psychology: An Introduction to the Study of Human Behavior. By FLORENCE L. GOODENOUGH. Second edition. New York: D. Appleton-Century Co. 1945. $3.75.

THE second edition of this widely used text-book is larger (723 pages in place of 619) and more profusely illustrated (123 figures in place of 81) than the first edition, which appeared in 1934. The author has preserved the best features of the original formulation, while major reorganization of several important chapters has strengthened the general integration of the subject-matter, and the addition of new material has greatly enriched the presentation.

The general plan of the book's organization remains a chronological one in that the principal data of psychology are considered in so far as possible in their relation to the developmental history of the individual, beginning with the prenatal period and continuing to old age. The method of presentation, which is well suited to the beginning student, includes a number of very useful pedagogical devices and has in its favor an obviously logical structure and a clear simple style, both of which contribute a high degree of "teachability." There is a commendable and in the main successful attempt to present psychology as a practical subject with direct bearing upon the student's everyday life.

The manner in which certain subjects are presented may be criticized, although the criticism probably indicates differences of opinion rather than any major weakness in the book. In Chapter XIII, which is entitled "Social and Emotional Behavior of Young Children," the discussion of play is somewbat inadequate and the speculations of Groos, Spencer and others are presented quite uncritically, although the circularity of reasoning upon which they are based might be stressed to the reader's profit. On the whole the data of comparative psychology do not seem to have been employed to their full effectiveness. The discussion of higher psychological processes in subhuman animals tends to be superficial (Chapters X and XIV), and in connection with her consideration of mental disease Goodenough waxes enthusiastic over N. R. F. Maier's work on "neurotic" behavior in rats. This is of course the author's privilege, but she will probably be criticized for omitting any mention of the several investigators who have published contradictory results, and for the general failure to acknowledge the highly controversial nature of Maier's original interpretation of the phenomena under consideration.

These are minor and debatable criticisms, but somewhat more serious questions can be raised concerning the rather extended treatment of several non-psychological subjects. Chapter III ("Our Hereditary Background") embodies a condensed but nonetheless lengthy discussion of chromosomal mechanics. The reviewer can not help but wonder whether those facts of inheritance which may be important to the beginning student of psychology could not have been presented without recourse to a detailed description of such highly specialized genetic problems as those involved in gametogenesis. Similarly one finds in Chapter IV ("Prenatal Development") several pages of material which would not be out of place in a text on introductory embryology; and although it is of general scientific interest the information presented has very little obvious connection with the psychological material which follows.

It is not difficult to understand how a desire to present a complete picture of ontogenetic development should lead to the inclusion of a good deal of elementary genetics and embryology, but it is hard to rationalize the perpetuation of the pointless treatment

of neuroanatomy which has formed a regular part of standard psychology texts for many decades.

For some obscure reason psychologists traditionally have burdened their students with detailed descriptions of the nervous system, apparently in the hope that knowledge of this sort will in some mysterious fashion prove helpful to an understanding of psychological events. The regrettable fact is that to date there remains a vast chasm between the established data of mental activity and those of neurology; and the reviewer doubts seriously whether a purely descriptive account of the anatomy of the nervous system can be of any assistance to the student's comprehension of psychological phenomena. Possibly the advanced reader profits from a competent review of certain aspects of neurophysiology such as those involved in recent studies on electrical activity of the brain or acetylcholine and cholinesterase metabolism, but even here the potential psychological implications of the physiological data are so speculative that one is tempted to deny the original assumption and to insist that the psychology student's efforts might more profitably be directed toward a fuller investigation and better understanding of phenomena which belong within the psychological sphere as currently defined.

Obviously there are other points of view and it may well be that teachers of psychology will welcome precisely those sections in Professor Goodenough's book which the reviewer is inclined to regard as unnecessary. In any event the inclusion of this material need not detract from the volume's obvious value as a text-book nor from the fact that the author has done a commendable job of synthesizing the important material in her field.

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THE STORY OF THE WRIGHT BROTHERS

The Wright Brothers. By FRED C. KELLY. New York: Harcourt, Brace and Company. 1945. $3.50.

HERE, for the first time, is a complete and authentic record of the first men who achieved, sustained and controlled flight in a heavier-than-air flying machine—a biography authorized by Orville Wright.

The story begins with the boyhood background of Orville and Wilbur Wright, and covers, in interesting form, their many dreams, activities and enterprises which led to that epoch-making event at Kitty Hawk, North Carolina, on December 17, 1903, when, with Orville Wright at the controls, their bi-plane took off from the sand dunes and made flying history.

Following the first successful flight, a detailed account is given of their difficulties with the press, the lack of interest first shown by the United States Army, their successful flights and demonstrations in Europe, their engagement in the aviation business, their building the first airplane for the United States Army and their patent suit with Curtiss.

This story of the Wright Brothers is the most complete single volume depicting the history of their work in aviation and clarifies beyond question the disputes which finally culminated in their being given proper and full credit for making the first man-carrying controlled and sustained flight in a heavier-than-air machine.

Mr. Kelly has done a remarkable job in his book, and has compiled, in a form delightful to read, a great mass of details and information which is a splendid record of our two foremost American pioneers in aviation, Orville and Wilbur Wright.

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